智慧水稻栽培數位分身

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ABSTRACT

To enable adaptive responses to abrupt shifts in operational conditions, smart farming necessitates real-time management systems, often called cyber-physical systems. These systems achieve dynamic adjustments by incorporating sensing and monitoring capabilities, intelligent analytics and planning, and the efficient management of various farm operations across different processes. To minimize farmer intervention and enhance autonomy, digital twin systems emerge as pivotal components, creating digital replicas of intricate physical systems. In the context of Agriculture 4.0, this paper focuses on the development of a smart agriculture platform with a specific case study for paddy cultivation. This comprehensive platform integrates an AIoT-driven data collection and monitoring system, a smart irrigation system, and an AI model service system for image and data analysis. The web-based user interface includes Line notification services. By merging digital twins with Artificial Intelligence of Things (AIoT), big data analytics, computer vision, human expertise, and machine learning, the aim is to enhance the monitoring, diagnosis, prediction, and optimization of various parameters within a sophisticated paddy cultivation system. Utilizing diverse computer vision and AI techniques, this study implemented and examined several models for key growth and environmental indexes in paddy cultivation. These models encompass image recognition for individual paddy crops with 92% confidence, and crop height calculation with a 10% error rate, green coverage calculation (tillering status), leaf color classification for determining nitrogen levels, paddy disease classification and detection, soil crack width calculation, and weather monitoring.

Keywords: Digital Twin, Agriculture 4.0, Cyber-Physical System, AIoT, Paddy, Machine Learning, Precision Agriculture, Computer Vision